LUMBER YIELD and LOG VALUES of

WHITE FIR

by Eldon M. Estep and Douglas L. Hunt

PACIFIC NORTHWEST
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SUMMARY

Lumber grade recovery from 284 southern Oregon white fir logs was determined in a cooperative study conducted in 1961. Value of the lumber from each log was used to compute values of individual log grade-log diameter classes. Methods used to collect lumber grade yield data allowed development of basic log value information applicable to grading and scaling practices used both east and west of the Cascade Range.

Effect on lumber yield of (1) log diameter and (2) log grade is illustrated in curves which relate lumber value and log value to log size and quality. Overrun and defect observed in the study logs are graphically shown. While the log mix included in the study does not necessarily represent any sawmill's normal supply, timber processors--as well as timber buyers and sellers--can use the information reported here as a basis for predicting lumber and log values from any given mix of log grades and sizes.

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INTRODUCTION

Utilization of timber species locally referred to as "white firs" has expanded in recent years in nearly every area where these true firs grow. As a result, sawmill operators and loggers have frequently found themselves regarding white firs with increased interest. Knowledge of recovery values of white fir timber has not kept pace, however, with the transformation of the former weed trees into commercial timber. The fact that several species are generally termed "white fir" has also contributed to a lack of understanding of the actual value of white fir timbers. To provide a better basis for evaluating this timber, a cooperative study of lumber grades recovered from white fir (*Abies concolor* (Gord. & Glend.) Lindl.) was made at Medford, Oreg., in 1961. Results of that study are reported here.

The reader should keep in mind that these results are from one 3-shift study at a single mill and may not reflect average experience of white fir producers over an extended period. In fact, personnel at the cooperating sawmill report that their average defect and overrun are about half of those found in this intensive study. They suggest that this may be due to differences in volumes obtained in everyday scaling as compared with the carefully scaled volumes of the study logs.

Nonetheless, these study results are a valid indication of white fir lumber output under specific conditions. Additional studies will be valuable in building a broader sample from which white fir timber may be better evaluated. In the meantime, mill operators may relate their own experience to these study results by using simplified batch tests.

METHOD

Log Sample

At the time the log sample was chosen, white fir logs were supplied to Kogap Manufacturing Co.'s sawmill in Medford, Oreg., from two sale areas located on public lands in Jackson County, Oreg. Several true fir species were hauled to the mill together, but only *Abies concolor* logs were included in the study.

Log Selection

As logs were delivered to the storage area, white fir logs were set aside for the sample. Although most study logs were assembled as they were randomly delivered to the mill, additional logs were chosen from the mill's storage decks to provide sizes and grades not then being hauled.

The objective of providing a fair number of logs in each grade and diameter class governed sample log selection. The sample drawn, therefore, does not necessarily represent the log mix available to any given mill. To estimate the lumber yield of a given mill (using data developed in the study), relative proportions of each log grade and diameter class available to that mill must be used as weighting factors.

Log Diagraming, Grading, and Scaling

The visible surface and end characteristics of each log were critically examined in the mill yard. These characteristics were recorded on prepared forms. Thus, the relationship of the external characteristics of a log to its lumber grade yield could be studied in detail to develop tree grades or refine log grades.

Study logs were graded and scaled according to practices used on both the west side and east side of the Cascade Range. West-side official Bureau log grades[1/] for hemlock were assigned in the yard by a U.S. Forest Service regional check scaler. Before the logs were bucked, the check scaler also scaled them in the yard in accordance with Bureau scaling practices (maximum scaling length, 40 feet). This long-log sample included 284 logs.

After logs over 22 feet long were marked for bucking into two pieces, they were graded by the same Forest Service check scaler by Trial Log Grades for Associated Species (see Appendix) used on the east side of the Cascades. East-side log scale[2/] (maximum scaling length, 16 feet) was not determined until the logs had been bucked on the sawmill deck. Thus, adequate time for careful grading in the yard was allowed, as well as for observation of all log ends before the logs were scaled. A total of 520 short logs (10 to 22 feet in length) resulted when sample logs were bucked on the mill deck.

In timber appraisal on the west side of the Cascade Range, limited use is made of official Bureau rules as applied to short logs. To provide lumber grade recovery information on this basis, west-side Bureau log grades and

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[1/] Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, Northern California, and Tillamook County Log Scaling and Grading Bureaus. 38 pp. 1954.

[2/] U.S. Forest Service. National Forest Scaling Handbook. 101 pp. 1956 revision.

scale were applied to the 520 short logs. Thus, log scale information was developed by three different scaling practices:

Scaling practice	Gross log scale (in board feet)	Defect deduction (in board feet)	Net log scale (in board feet)
West-side Bureau scale, applied to long logs	146,910	27,360	119,550
West-side Bureau scale, applied to short logs	162,610	32,100	130,510
East-side scale, applied to short logs	173,790	31,320	142,460

Logs delivered to the mill yard ranged from 12 to 40 feet in length. These were scaled as one log under west-side Bureau rules. Logs fed into the sawmill ranged in length from 10 to 12 feet. Both west-side Bureau grading and scaling rules were applied to these short logs. Official Bureau scaling differs from east-side scaling in three ways: diameter measurement, defect deductions, and maximum scaling length. These different practices result in scale variation. The variation attributable primarily to length is apparent in comparing the two west-side Bureau scales. The difference in scale attributed primarily to diameter differences can be seen by comparing west-side Bureau short-log scale with east-side short-log scale. Scale variations, due to both diameter and length, can be seen by comparing west-side Bureau long-log scale with east-side short-log scale.

Lumber Manufacture

The cooperating sawmill was equipped with a band headsaw and vertical band resaw, a combination that is representative of most mills sawing white fir. Sawing, drying, and surfacing practices of the mill were representative of industry practice.

Sawing. -- Study logs were sawn per agreement to obtain the highest value from each log. Most of the white fir volume was cut into 2-inch Dimension. Selects were sawn into 4/4-, 5/4-, and 7/4-inch thickness and Shop lumber was cut to 5/4-inch thickness. A minimum volume of 1-inch Common boards was desired.

The identity of lumber sawn from individual short logs was maintained by a color code until the consecutive sawing number of the log could be written on the face of the board. On the green sorting chain, each piece of lumber was tallied by its log number, grade, and rough green dimensions.

Kiln-drying. -- After the logs were sawn, study lumber was stacked for kiln-drying. Stickering and stacking were done by hand with well-designed and

well-built racks. Production schedules were used to dry the lumber in end-loaded, double-track, and single-track kilns. Excessive drying degrade was not found.

Surfacing. -- After kiln-drying, study lumber was dry-sorted by planing item and by the original green chain grademark. Thus, when one lot of lumber (such as 2X6 Standard) was surfaced, graded, and tallied, the surfaced dry grade yield could be compared directly with the green grade input. Grading behind the planer was accomplished by certified company graders under the supervision of the same West Coast Lumber Inspection Bureau (WCLIB) inspector who had graded the stock on the green chain.

Dimension lumber and Common boards were graded in accordance with WCLIB[3/] rules. Shop and Selects were graded under Western Pine Association[4/] (WPA) rules.

The surfaced dry lumber output provided the basis for all grade yield data reported herein. To determine surfaced dry yield from individual logs, green-to-dry conversion factors were needed, since lumber identity by log number was not maintained beyond the green chain. Conversion factors were obtained by determining the percentage of lumber volumes by dry grades which developed from a single green grade. By means of these green-to-dry conversion factors, the rough green grade yield of each individual log was then converted to a surfaced dry grade yield.

Analysis of Data

Data were subjected to three separate analyses: (1) by short logs, according to east-side log grading and scaling practices; (2) by long logs, according to west-side log grading and scaling practices; and (3) by short logs, under west-side log grading and scaling practices. The following procedures were used:

1. Within each log grade (east-side grade or west-side grade), the logs in each 1-inch diameter interval were combined to form a log group. The yield of surfaced dry lumber (by lumber grade) from a log group

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[3/] West Coast Lumber Inspection Bureau. Standard grading and dressing rules for Douglas fir, west coast hemlock, Sitka spruce, western red cedar lumber. No. 15, 338 pp., illus. Portland, Oreg., March 1956, plus supplements.

[4/] Western Pine Association. Standard grading rules for Idaho white pine, white fir, ponderosa pine, larch, sugar pine, Douglas fir, lodgepole pine, red cedar, incense cedar, Englemann spruce lumber. 166 pp., illus. Portland, Oreg. 1960.

provided the basic data for computing log values. This information also provided the basis for the lumber grade recovery tables included in the appendix.

2. The volume of surfaced dry lumber in each lumber grade was multiplied by the appropriate 1960 price (listed in the appendix), and lumber grade yield values were added to compute the total value (in dollars) of the lumber yield from each log group.

3. For each log group, the value of lumber was divided by the volume of surfaced dry lumber to give dollars per thousand board feet, lumber tally. This value ratio, referred to as unit lumber value, is a convenient index of lumber grade yield and is useful in comparing the quality of lumber produced from various grades and/or sizes of logs.

4. For each log group, the value of lumber was divided by the net log scale to give dollars per thousand board feet, net log scale. This log value ratio, referred to as unit log value, is especially meaningful to those engaged in buying and selling timber since it reflects not only the quality but also the quantity of lumber recovered.

RESULTS AND DISCUSSION--EAST-SIDE PRACTICE

The distribution of 520 study logs, graded and scaled by east-side diameter classes and log grades, is shown in table 1. Grades and sizes of logs included in the study may be considered a valid indication of log quality and sizes available from white fir timber stands in southern Oregon. Timber quality is low, and logs fit almost entirely into log grades 3 and 4. Only a few grade 2, and almost no grade 1, logs may be found.

Results of analyses of study data are presented largely in tabular and graphic form. The log volume, lumber volume, and lumber value for the logs within each log grade are shown in table 2. This summary of findings provides the basis for most of the subsequent discussion. In addition, table 2 permits further analysis of results if desired.

Lumber Grade Yield by Log Grade-Diameter Class

Grouping study logs into 6-inch diameter intervals allows one to more readily visualize the influence of log quality and log size on lumber yield. Relevant data for each of the diameter intervals have been summarized in table 3, except that diameter intervals containing less than 10 logs were omitted from this table.

The quality variability found in timber is carried over into lumber yield. Although examination of the lumber grade yield portion of table 3 shows that grouping at 6-inch intervals smooths variability, an accurate generalization of lumber grade yield is still provided.

Table 1.--Distribution of 520 white fir short logs, by diameter and log grade; southern Oregon, 1961

Diameter (inches)	Log grade[1/]				
	No. 1	No. 2	No. 3	No. 4	Total
	Number				
6- 8	--	--	--	22	22
9-11	--	--	--	52	52
12-14	--	--	41	20	61
15-17	--	--	60	15	75
18-20	--	2	70	6	78
21-23	--	5	56	5	66
24-26	--	2	53	3	58
27-29	--	1	54	1	56
30-32	--	1	29	1	31
33-35	1	3	11	--	15
36-38	1	1	4	--	6
Total	2	15	378	125	520

[1/] Trial Log Grades for Associated Species.

NOTE: The heavy lines enclose those log grade—diameter intervals that are included in table 3. Data from all logs except No. 1 grade are summarized in tables 10-12 of the appendix.

Table 2.--Net log scale, total lumber volume, and total lumber value for white fir, by diameter and log grade; southern Oregon, 1961

Log diameter (inches)	Log grade[1/]											
	No. 1			No. 2			No. 3			No. 4		
	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value
	--- Bd. ft. ---		Dollars	--- Bd. ft. ---		Dollars	--- Bd. ft. ---		Dollars	--- Bd. ft. ---		Dollars
6	--	--	--	--	--	--	--	--	--	20	35	2.09
7	--	--	--	--	--	--	--	--	--	200	357	20.31
8	--	--	--	--	--	--	--	--	--	400	698	38.16
9	--	--	--	--	--	--	--	--	--	650	925	54.51
10	--	--	--	--	--	--	--	--	--	1,110	1,589	86.71
11	--	--	--	--	--	--	--	--	--	1,110	1,569	88.60
6-11	--	--	--	--	--	--	---	--	--	3,490	5,173	290.38
12	--	--	--	--	--	--	550	757	40.84	860	1,186	62.70
13	--	--	--	--	--	--	1,690	2,230	121.60	420	622	29.99
14	--	--	--	--	--	--	1,840	2,502	134.29	730	1,018	54.63
15	--	--	--	--	--	--	2,960	3,667	191.82	1,060	1,526	78.05
16	--	--	--	--	--	--	2,750	3,389	182.01	530	704	36.11
17	--	--	--	--	--	--	3,790	5,062	274.20	650	666	34.15
12-17	--	--	--	--	--	--	13,580	17,607	944.76	4,250	5,722	295.63
18	--	--	--	160	225	15.06	5,390	6,949	377.96	360	416	22.65
19	--	--	--	--	--	--	4,490	5,588	300.07	450	566	27.30
20	--	--	--	330	364	32.09	6,550	7,830	422.45	430	611	27.01
21	--	--	--	240	336	29.68	3,240	4,104	234.92	370	514	22.45
22	--	--	--	--	--	--	7,010	8,865	478.86	920	1,223	56.24
23	--	--	--	1,190	1,452	98.34	7,510	9,074	496.34	--	--	--
18-23	--	--	--	1,920	2,377	175.17	34,190	42,410	2,310.60	2,530	3,330	155.65
24	--	--	--	--	--	--	5,780	6,888	368.84	250	447	22.59
25	--	--	--	--	--	---	8,030	9,564	516.29	780	887	42.95
26	--	--	--	840	731	45.10	7,670	9,074	501.72	--	--	--
27	--	--	--	--	--	--	7,630	8,941	489.72	--	--	--
28	--	--	--	440	463	34.33	10,520	13,344	798.10	670	715	37.87
29	--	--	--	--	--	--	7,880	10,001	592.57	--	--	--
24-29	--	--	--	1,280	1,194	79.43	47,510	57,812	3,267.24	1,700	2,049	103.41
30	--	--	--	410	692	60.56	7,030	9,394	530.01	--	--	--
31	--	--	--	--	--	--	3,490	4,014	224.60	630	723	38.56
32	--	--	--	--	--	--	6,810	8,408	499.08	--	--	--
33	490	871	91.31	580	929	63.52	2,970	3,602	213.79	--	--	--
34	--	--	--	500	791	67.56	3,820	4,521	256.70	--	--	--
35	--	--	--	680	1,009	68.47	670	702	51.49	--	--	--
30-35	490	871	91.31	2,170	3,421	260.11	24,790	30,641	1,775.67	630	723	38.56
36	400	673	64.89	840	839	41.46	570	779	77.72	--	--	--
37	--	--	--	--	--	--	2,120	2,929	170.78	--	--	--

[1/] Trial Log Grades for Associated Species.

Table 3.--Log input, lumber yield, and lumber value for white fir of southern Oregon, based on east-side log grading and scaling practices, 1961[1/]

LOG INPUT AND LUMBER YIELD

Item	Log grade and diameter interval						
	No. 3				No. 4		
	12-17	18-23	24-29	30-35	6-11	12-17	18-23
Logs.....number..	101	126	107	40	74	35	11
Gross log scale.....board feet..	14,670	39,840	60,470	31,330	3,690	4,540	3,210
Net log scale.....board feet..	13,580	34,190	47,510	24,790	3,490	4,250	2,530
Defect.....percent..	7	14	21	21	5	6	21
Lumber tally.....board feet..	17,607	42,410	57,812	30,641	5,173	5,722	3,330
Overrun.....percent..	30	24	22	24	48	35	32
GRADE YIELD (in percent of dry lumber tally)							
Select:							
C	1	1	2	2	2	1	0
D	0	1	2	2	0	0	0
Total	1	2	4	4	2	1	0
Shop:							
Molding	0	1	2	4	1	0	0
All Shop and Outs	1	1	4	6	0	0	3
Total	1	2	6	10	1	0	3
Common:							
Standard and Better	49	46	41	37	54	45	31
Utility	30	30	28	28	27	31	34
Economy	19	20	21	21	16	23	32
Total	98	96	90	86	97	99	97
LUMBER VALUE (in dollars)							
Basis:							
Per M b.m. lumber tally	53.66	54.48	56.51	57.95	56.13	51.67	46.74
Per M b.m. net log scale	69.57	67.58	68.77	71.63	83.20	69.56	61.52

[1/] Trial Log Grades for Associated Species; maximum log scaling length of 16 feet.

A significant proportion of Shop and Select lumber was produced only from the larger diameter grade 3 logs (fig. 1). In contrast to the 14 percent of Shop and Selects found in 30- to 35-inch, grade 3, white fir logs, a recent study[5/] showed 43 percent of Shop and 6 percent of Selects sawed from Shasta red fir logs of the same log grade-diameter class.

As might be expected from the size and quality of white fir logs found, lumber produced was largely limited to the Common grades. This was mostly 2-inch stock. One-inch Common boards made up only 4 percent of the total lumber sawed.

Lumber Value as an Index of Lumber Grade Yield

A convenient weighted index to lumber grade yield is provided when lumber value is expressed in dollars per thousand board feet, lumber tally. Lumber quality obtained from logs of various qualities and sizes may thus be easily compared. The overall effect of log grade and diameter is presented graphically in figure 2. A unit lumber value (dollars per thousand board feet, lumber tally) was calculated from the raw study data and plotted for each log grade-diameter class. A regression line which best fitted the data was drawn for each log grade to illustrate the relationship between two variables, unit lumber value and log diameter. Generally, lumber value increased as diameter increased in log grade 3, but value fell off as log size increased in grade 4. Examination of lumber grade yields in table 3 and figure 1 shows why these relationships exist. For grade 3 logs, the total percentage of Utility and Economy lumber remained virtually unchanged, but increasing amounts of Shop and Selects were cut as log diameter increased. Only minor amounts of Shop and Select stock were cut from grade 4 logs regardless of size. Instead, percentages of Standard and Better were high in the smaller diameter range but were reduced as diameters increased. Correspondingly, Utility and Economy stock increased with increasing log size to a high of 66 percent for grade 4 logs in the 18- to 23-inch diameter class.

Log Value by Log Grade and Log Diameter

Product yield may be considered strictly in terms of lumber value. Log value, expressed in dollars per thousand board feet, net log scale, is often more useful in comparing value of lumber obtained from logs of varying grade and diameter, since logs are generally purchased on a net log scale basis. Log values for white fir logs sawed in this study are shown in figure 3.

[5/] Grantham, John B., and Hunt, Douglas L. Lumber yield and log values of Shasta red fir. Pac. NW. Forest & Range Expt. Sta. U.S. Forest Serv. Res. Paper PNW-2, 30 pp., illus. 1963.

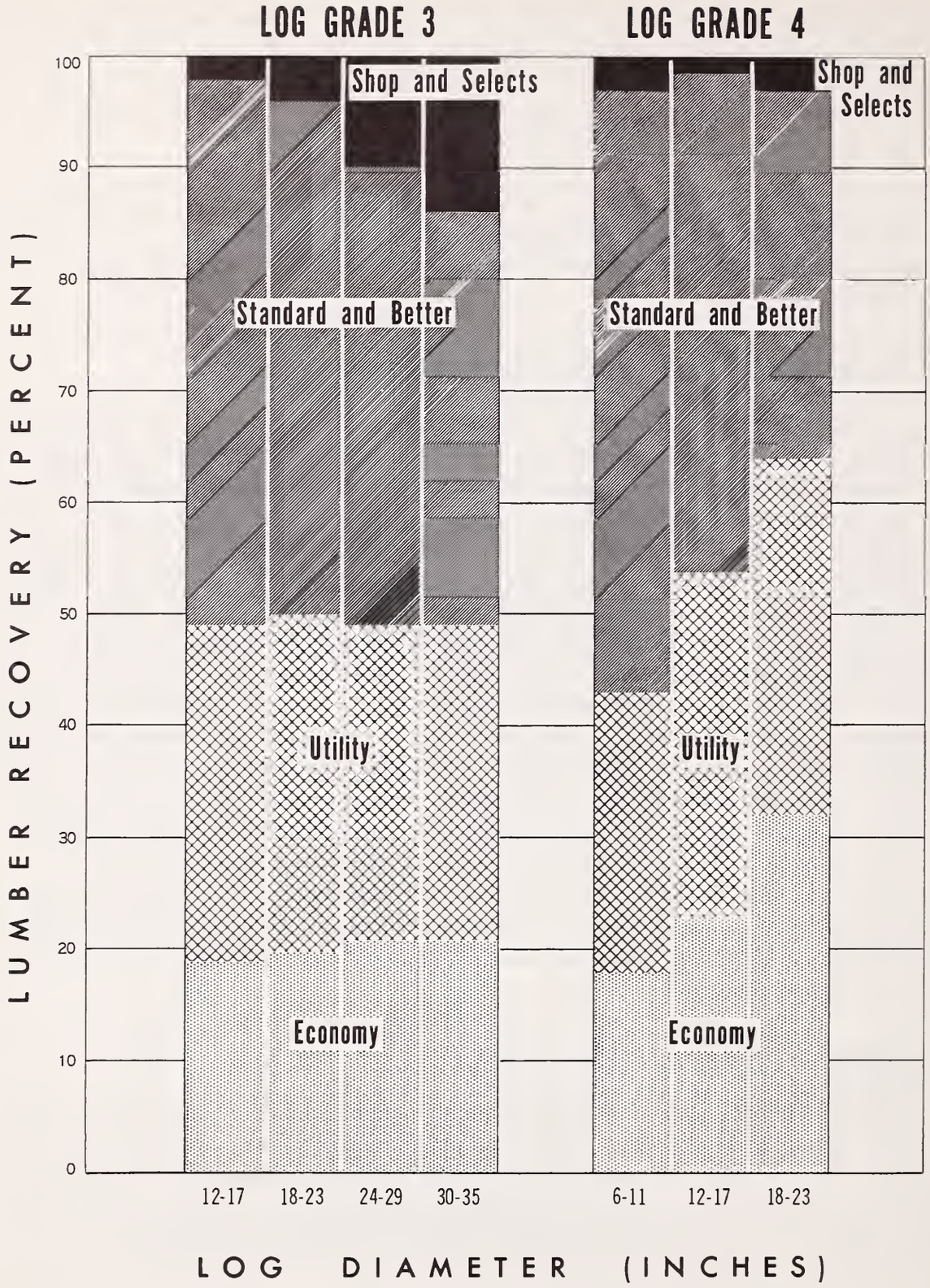

Figure 1.--Surfaced dry lumber grade recovery, by 6-inch diameter classes and by log grades, based on Trial Log Grades for Associated Species.

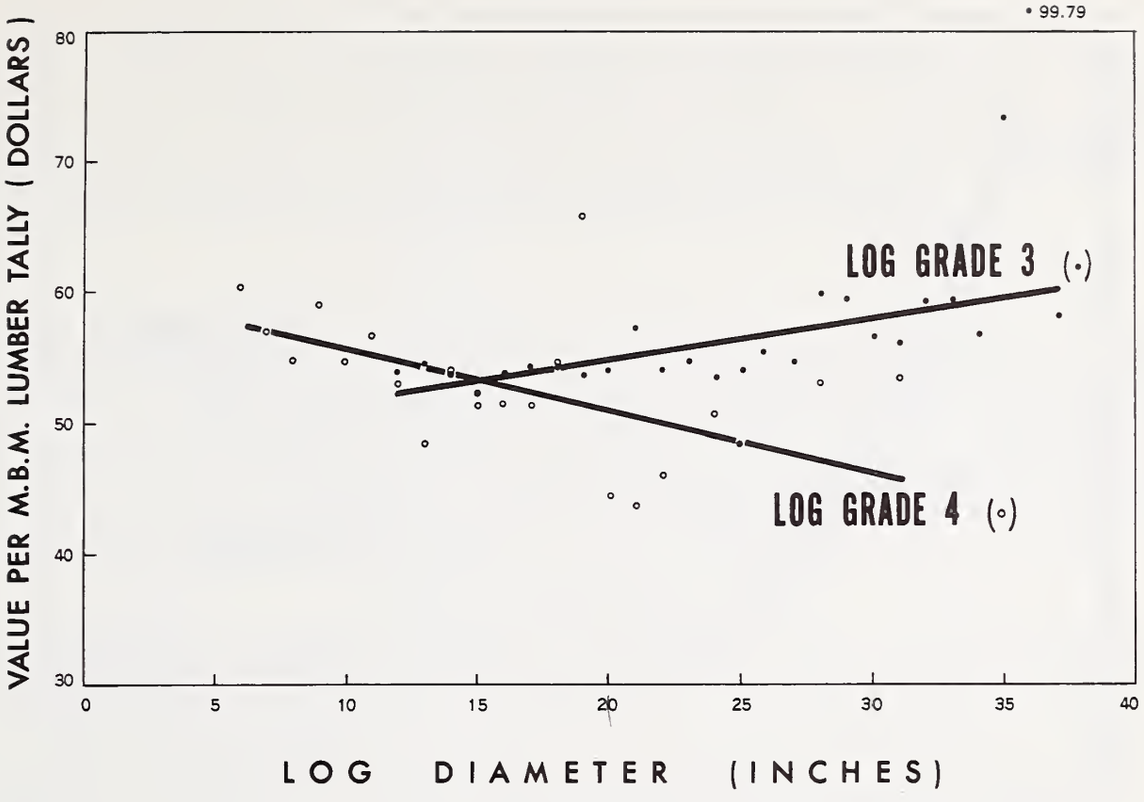

Figure 2.--Relationship of lumber value (dollars per thousand board feet, dry lumber tally basis) to log diameter by log grade (Trial Log Grades for Associated Species).

The effect of overrun (spread between lumber volume output and net log scale input) may be seen when the lumber value curves in figure 2 are compared with log values presented in figure 3. The relationship of product yield to diameter, which is linear on a lumber value basis, becomes curvilinear on a log value basis and involves unit value of lumber plus lumber volume.

Overrun

Curves of overrun for the log grades and sizes sampled are shown in figure 4. Although overrun data plotted for the diameter classes in log grade 4 generally seem intermixed with points plotted for grade 3, a covariance analysis indicates that the regression lines are significantly different. Examination of the figure shows that individual plotting points for the log grade 3 data are relatively well grouped along the grade 3 regression line. In contrast, considerably more variation is shown by the log grade 4 data. Although the plotting points seem almost randomly distributed, the calculated regression line for log grade 4 indicates that the overrun data for log grade 4 has a definite trend.

Variations in overrun such as those shown will not be new to readers accustomed to working with overruns from individual logs or small groups of logs. The multitude of combinations of log characteristics found in a single log grade-diameter class allow a wide variation in volumes recovered.

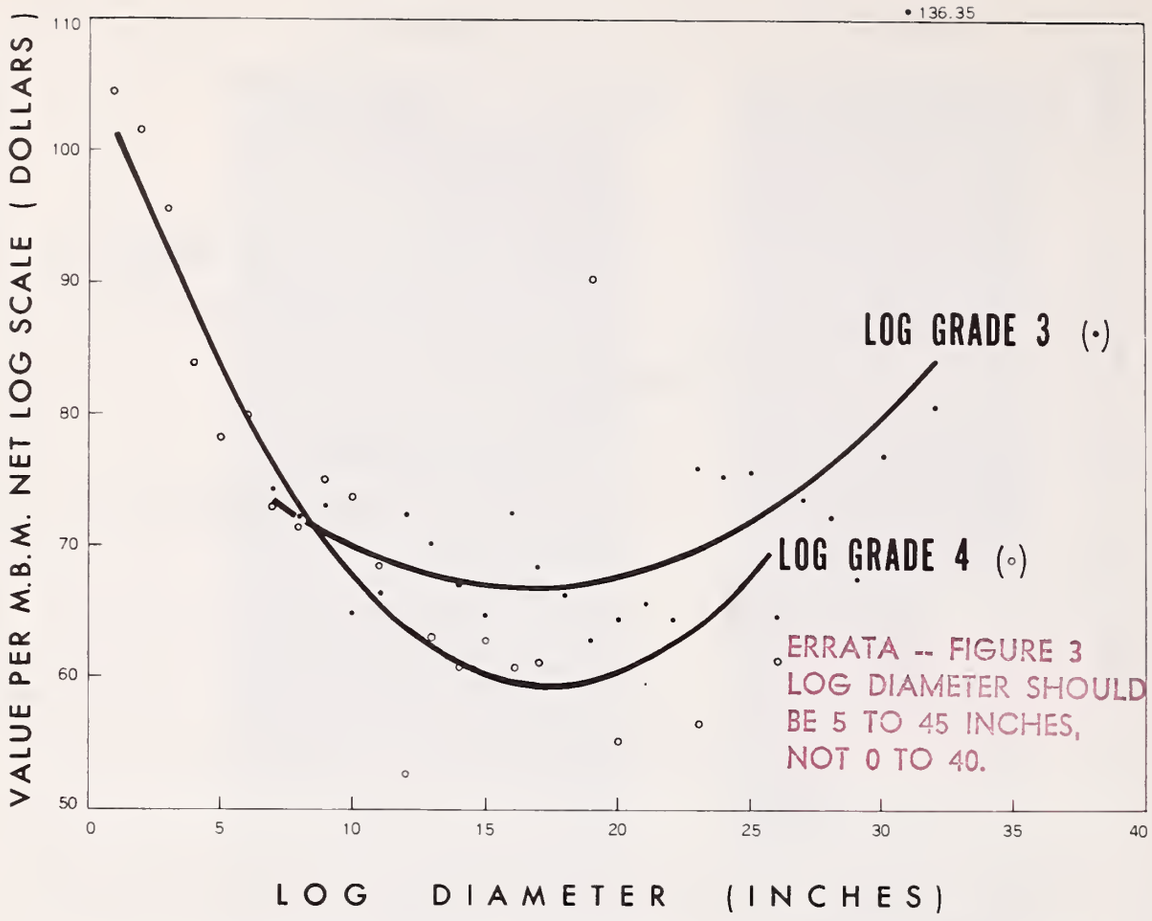

Figure 3.--Relationship of log value (dollars per thousand board feet, net log scale) to log diameter by log grade (Trial Log Grades for Associated Species).

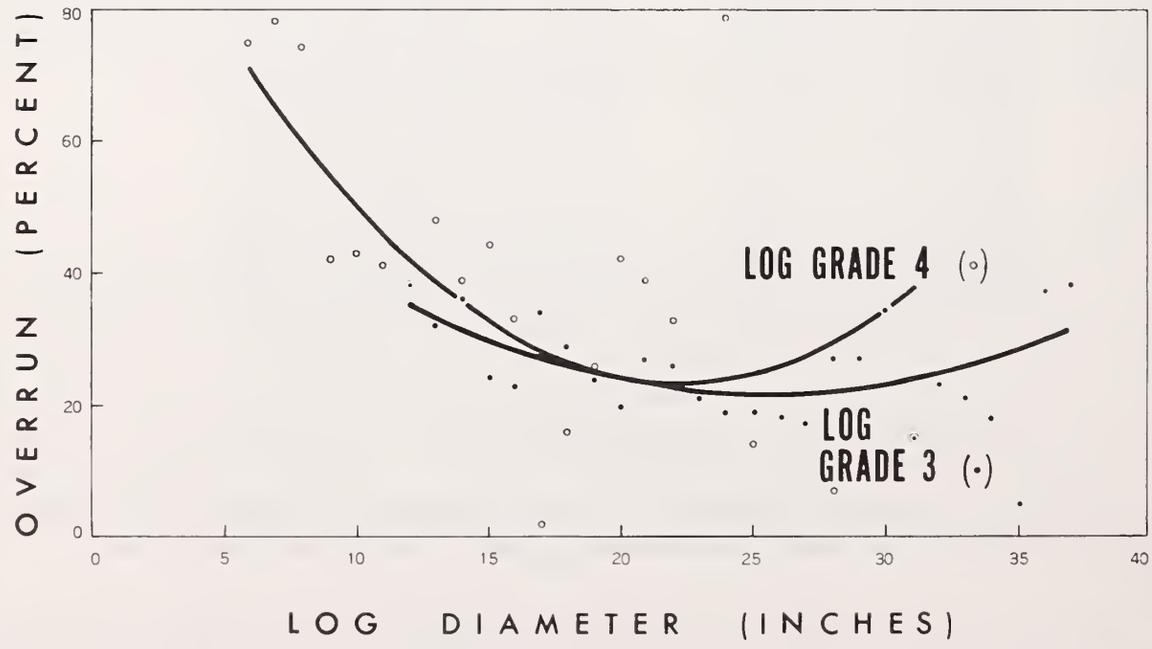

Figure 4.--Relationship of overrun to log diameter by log grade (Trial Log Grades for Associated Species).

Though all lumber in the study which would fit into a lumber grade was tallied and included in this analysis, normal operating practice at the study mill was to convert low-grade Economy material to chips. Accordingly, a higher Economy grade mix was offered to the mill's customers. Prices received were thus slightly higher than average Economy prices experienced in the region, but lumber overrun obtained by the cooperating mill was reduced.

Defect

Calculated regression lines for the percent of scaled defect are shown for the grades 3 and 4 logs sampled (fig. 5). As was the case with overrun, variation of individual diameter-class plotting points from the regression line is greater for log grade 4 than for the other log grade. Covariance analysis shows that the regression line for grade 3 is significantly different from that of log grade 4.

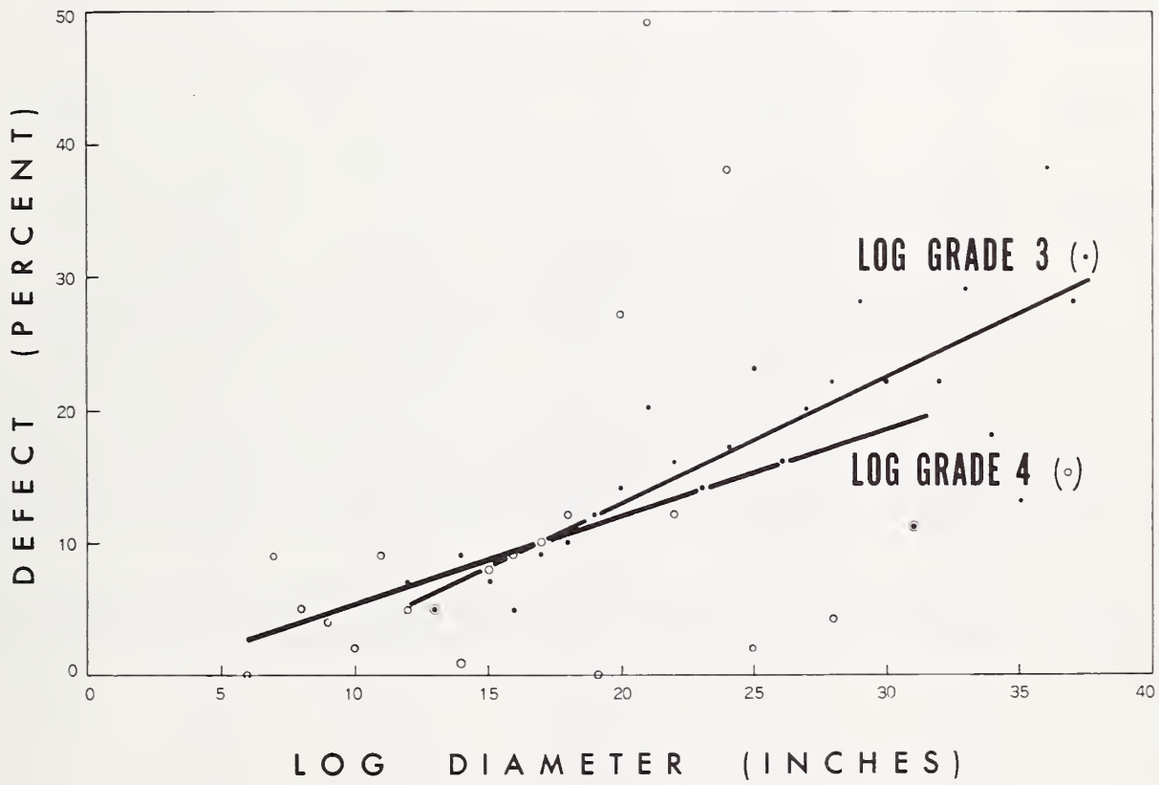

Figure 5.--Relationship of scaled defect to log diameter by log grade (Trial Log Grades for Associated Species).

RESULTS AND DISCUSSION--WEST-SIDE PRACTICE

Since the customary west-side practice is to apply Bureau grading and scaling practices to long logs, the study results obtained by applying west-side grades and scale to 520 short logs (up to 22 feet in length) are given limited treatment in this report. This section is primarily devoted to study results obtained from 284 long logs graded and scaled in accordance with west-side practice. Their distribution by quality and size classes is shown in table 4.

Table 4.--Distribution of 284 white fir long logs, by diameter and log grade; southern Oregon, 1961[1/]

Diameter (inches)	No. 2	No. 3	Total
	Number		
6- 8	--	26	26
9-11	--	32	32
12-14	9	36	45
15-17	27	17	44
18-20	25	11	36
21-23	22	11	33
24-26	15	9	24
27-29	21	5	26
30-32	11	1	12
33-35	6		6
Total	136	148	284

[1/] Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, Northern California, and Tillamook County Log Scaling and Grading Bureaus.

NOTE: The heavy lines enclose those log-grade diameter intervals that are included in table 6. Data from all logs are summarized in tables 13-14 of the appendix.

Timber quality was such that sample logs fitted only west-side log grades 2 and 3. White fir logs which meet west-side specifications for Peeler and No. 1 log grades may be considered rare in the southern Oregon area sampled in this study. Log volume, lumber volume, and lumber value of the study logs are given in table 5. The 284 logs are grouped by 1-inch diameter intervals within each log grade.

Table 5.--Net log scale, total lumber volume, and total lumber value for white fir, by diameter and log grade; southern Oregon, 1961

Log diameter (inches)	Log grade[1/]					
	No. 2			No. 3		
	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value
	Bd. ft.		Dollars	Bd. ft.		Dollars
6	--	--	--	--	--	--
7	--	--	--	350	774	43.50
8	--	--	--	820	1,790	100.17
9	--	--	--	1,020	2,096	119.45
10	--	--	--	620	1,352	67.52
11	--	--	--	1,140	1,992	110.94
6-11	--	--	--	3,950	8,004	441.58
12	--	--	--	1,390	2,560	134.86
13	--	--	--	2,920	5,325	287.42
14	1,780	3,022	161.04	1,520	3,085	167.17
15	1,990	3,179	167.78	1,230	2,114	106.91
16	2,820	4,215	229.63	1,140	2,117	110.01
17	2,410	3,860	205.35	1,900	3,153	176.15
12-17	9,000	14,276	763.80	10,100	18,354	982.52
18	2,020	3,333	188.70	1,260	2,276	111.32
19	2,330	3,461	191.73	840	1,501	80.43
20	5,830	8,403	474.56	2,030	3,546	188.50
21	3,500	4,890	284.75	1,570	2,191	113.88
22	7,880	11,290	630.10	1,810	2,856	140.50
23	1,930	2,568	147.08	1,890	3,175	160.76
18-23	23,490	33,945	1,916.92	9,400	15,545	795.39
24	2,780	3,795	217.48	3,140	4,628	224.57
25	3,930	6,150	349.03	1,420	2,229	138.22
26	4,980	6,772	391.52	1,620	2,354	122.08
27	11,230	15,880	947.93	1,060	1,503	82.97
28	3,600	5,436	345.56	1,160	1,438	76.43
29	3,370	4,309	278.78	3,220	4,426	223.31
24-29	29,890	42,342	2,530.30	11,620	16,578	867.58
30	5,270	7,009	377.28	--	--	--
31	6,330	8,077	547.11	--	--	--
32	1,230	1,666	135.21	1,420	1,791	84.83
33	2,760	3,971	211.00	--	--	--
34	5,090	6,992	489.25	--	--	--
30-35	20,680	27,715	1,759.85	1,420	1,791	84.83

[1/] Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, Northern California, and Tillamook County Log Scaling and Grading Bureaus.

Lumber Grade Yield by Log Grade-Diameter Class

Log input and lumber output have been further summarized by 6-inch diameter intervals. These groupings facilitate comparisons of the influence of log quality and log size on product yield. Pertinent data for each of the 6-inch diameter intervals containing 10 or more logs may be found in table 6.

Table 6.--Log input, lumber yield, and lumber value for white fir of southern Oregon, based on west-side log grading and scaling practices, 1961[1/]

LOG INPUT AND LUMBER YIELD

Item	Log grade and diameter interval							
	No. 2				No. 3			
	12-17	18-23	24-29	30-35	6-11	12-17	18-23	24-29
Logs.....number..	36	47	36	17	58	53	22	14
Gross log scale.....board feet..	10,300	27,970	39,370	25,750	4,340	10,850	11,740	15,030
Net log scale.....board feet..	9,000	23,490	29,890	20,680	3,950	10,100	9,400	11,620
Defect.....percent..	13	16	24	20	9	7	20	23
Lumber tally.....board feet..	14,276	33,945	42,342	27,715	8,004	18,354	15,545	16,578
Overrun.....percent..	59	45	42	34	103	82	65	43
GRADE YIELD (in percent of dry lumber tally)								
Select:								
C	1	2	3	4	1	1	1	1
D	0	1	2	4	0	0	0	1
Total	1	3	5	8	1	1	1	2
Shop:								
Molding	0	2	4	7	0	1	0	1
All Shop and Outs	0	2	5	6	0	2	2	3
Total	0	4	9	13	0	3	2	4
Common:								
Standard and Better	48	46	41	35	52	45	40	39
Utility	30	28	26	25	29	30	32	32
Economy	21	19	19	19	18	21	25	23
Total	99	93	86	79	99	96	97	94
LUMBER VALUE (in dollars)								
Basis:								
Per M b.m. lumber tally	53.50	56.47	59.76	63.50	55.17	53.53	51.17	52.33
Per M b.m. net log scale	84.87	81.61	84.65	85.10	111.79	97.28	84.62	74.66

[1/] Bureau log grades for hemlock; maximum scaling length, 40 feet.

Grouping in this manner obviously smooths variation resulting from the natural variability found in timber, but generalizations may be made from data shown in table 6 and figure 6. Figures in the grade yield portion of the table indicate that Shop and Select lumber accounted for a very small proportion of the lumber sawed from grade 3 logs. Production of Shop and Selects from grade 2 logs increased as log size increased to a total of 21 percent from 30- to 35-inch logs.

Lumber grade performance from this true fir may be contrasted with grade yields obtained in the recent study (footnote 5) of another, Shasta red fir, from the same general southern Oregon area. Grade 2 Shasta red fir logs 30 to 35 inches in diameter yielded 51 percent of Shop and Select lumber.

Lumber Value as an Index of Lumber Grade Yield

Expressing lumber value in dollars per thousand board feet, lumber tally, provides an index weighted according to lumber grade yield. This allows easy comparison of lumber quality obtained from logs of various qualities and sizes. Effect of log grade and diameter on product yield from 284 logs graded and scaled according to west-side practices may be seen in figure 7. A unit lumber value for each log grade–diameter class, calculated as described earlier, was plotted, and lines of best fit were drawn to illustrate the relationship of unit lumber value to log diameter within each log grade.

Lumber value for grade 2 logs increases with increasing diameter, but value of lumber produced from grade 3 logs decreases as log size increases. Examination of the points plotted for individual diameters shows that lumber value differences are slight between log grades below the 20-inch diameter. This suggests that the 14-inch diameter limit for grade 2 logs is an artificial limitation that might better be set at 20 inches. This would eliminate log-grading efforts to separate lumber value classes which apparently do not exist in white fir logs less than 20 inches in diameter under this grading system.

Log Value by Log Grade and Log Diameter

Logs are usually bought and sold on a net log scale basis, and a measure of product yield on this basis is especially useful. Lumber recovery values determined in this study, expressed in dollars per thousand board feet, net log scale, are shown in figure 8.

It is desirable at this point to explain why values plotted over log diameter may give horizontal lines for one log grade and an increasing or decreasing straight or curved line for another log grade. A statistical test of significance was applied to the calculated lines showing relationship of value to diameter. Only those curve forms (straight or curved lines) that could be statistically defended on the basis of significance (95-percent confidence level or greater) were shown in this report. When the data did not warrant a curve or straight line of either increasing or decreasing value, the average value for the log grade was drawn over all the diameters found in the study.

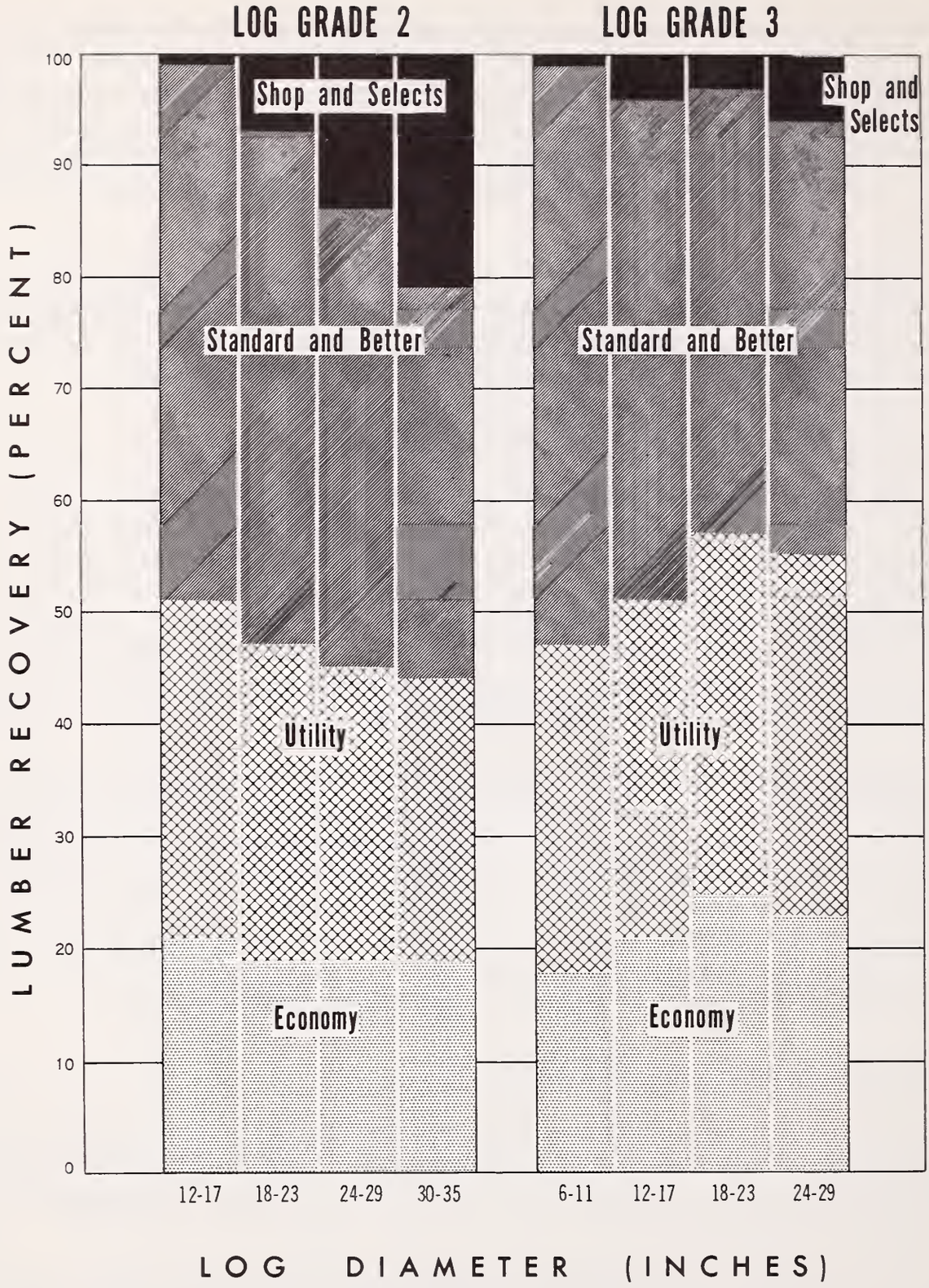

Figure 6.--Surfaced dry lumber grade recovery, by 6-inch diameter classes and by log grades; based on official Bureau log grading and scaling practices.

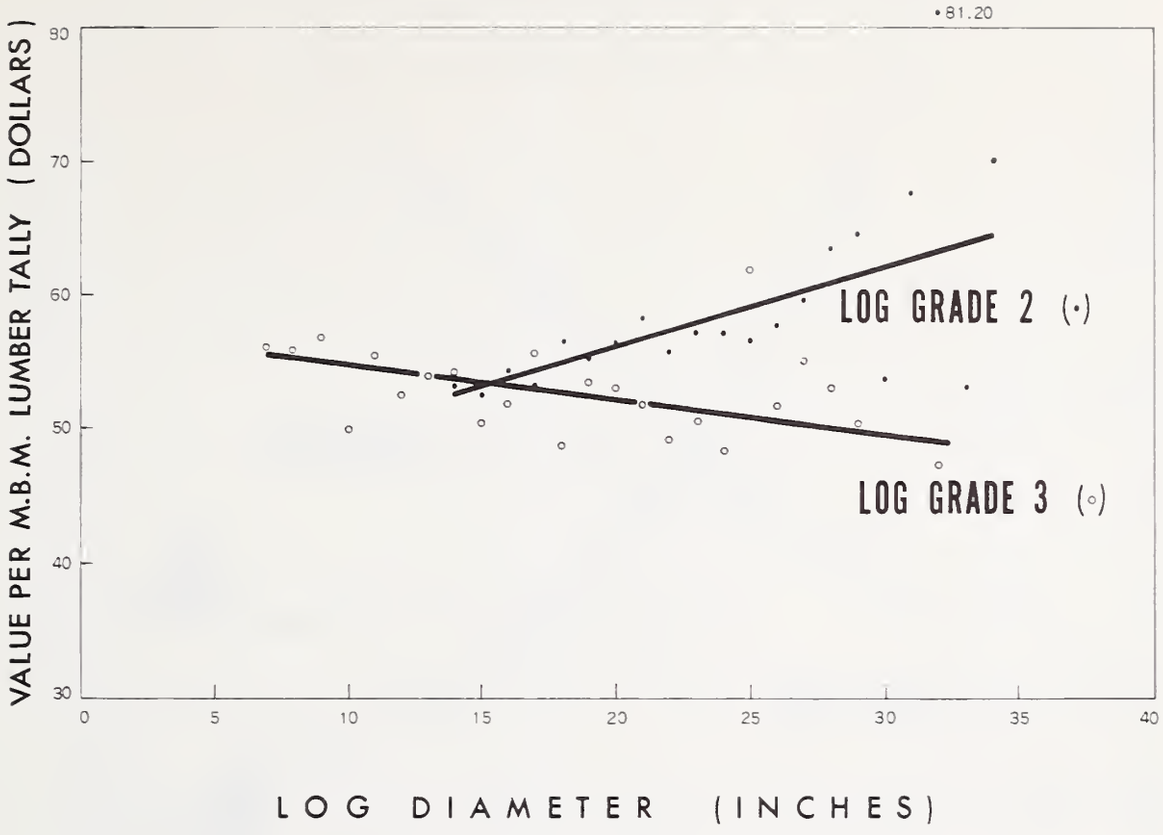

Figure 7.--Relationship of lumber value (dollars per thousand board feet, dry lumber tally basis) to log diameter by log grade (Official Log Scaling and Grading Rules, applied to logs up to 40 feet in length).

When the curves in figure 8 are compared with the lumber value curves in figure 7, the effect of overrun is readily apparent. Generally, the log value curves are considerably higher and have a different form than the curves of lumber value. Although a strong relationship of value and log size was found for log grade 2, the influence of overrun on log value for these logs was so variable that log diameter no longer exerted a significant influence on value. This resulted in an average log value for all diameters, but this unit log value was greater than the highest unit lumber value.

The grade 3 log value curve vividly illustrates the effect of high overruns found in small logs. Figure 7 shows that lumber value decreased at a constant rate from about $55.50 per thousand board feet, lumber tally, for 7-inch-diameter logs, to approximately $49 for 32-inch logs. The change in value on a net log scale basis is considerably different, however. Log value (fig. 8) dropped from about $122.50 for 7-inch logs to approximately $73 per thousand board feet, net log scale, for 32-inch diameters. Four-fifths of this decrease occurred in the 7- to 20-inch diameter range which included the smaller study logs.

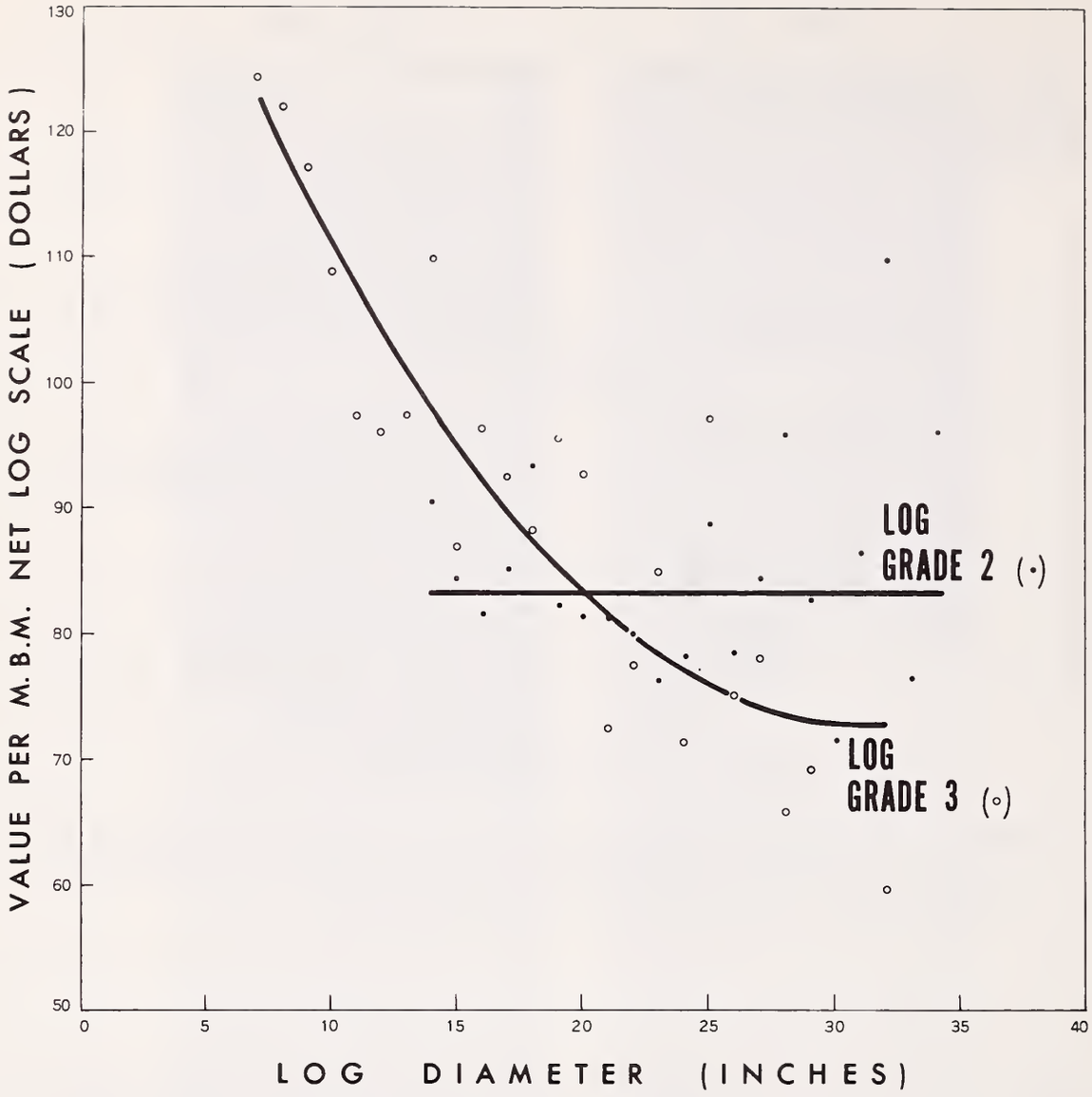

Figure 8.--Relationship of log value (dollars per thousand board feet, net log scale) to log diameter by log grade (Official Log Scaling and Grading Rules, applied to logs up to 40 feet in length).

Overrun by Log Grade

Although overrun is automatically included when product yield is considered in terms of log value (net log scale basis), overruns obtained from the study logs warrant separate consideration. Examination of figure 9 shows the relationship of overrun to log size for log grades 2 and 3. The overrun points plotted for individual diameters for one log grade seem generally intermixed with those of the other grade. Statistical analysis shows, however, that the relationships of overrun to log diameter for the two grades are significantly different. Covariance analysis was used to test for a significant difference in the regression lines.

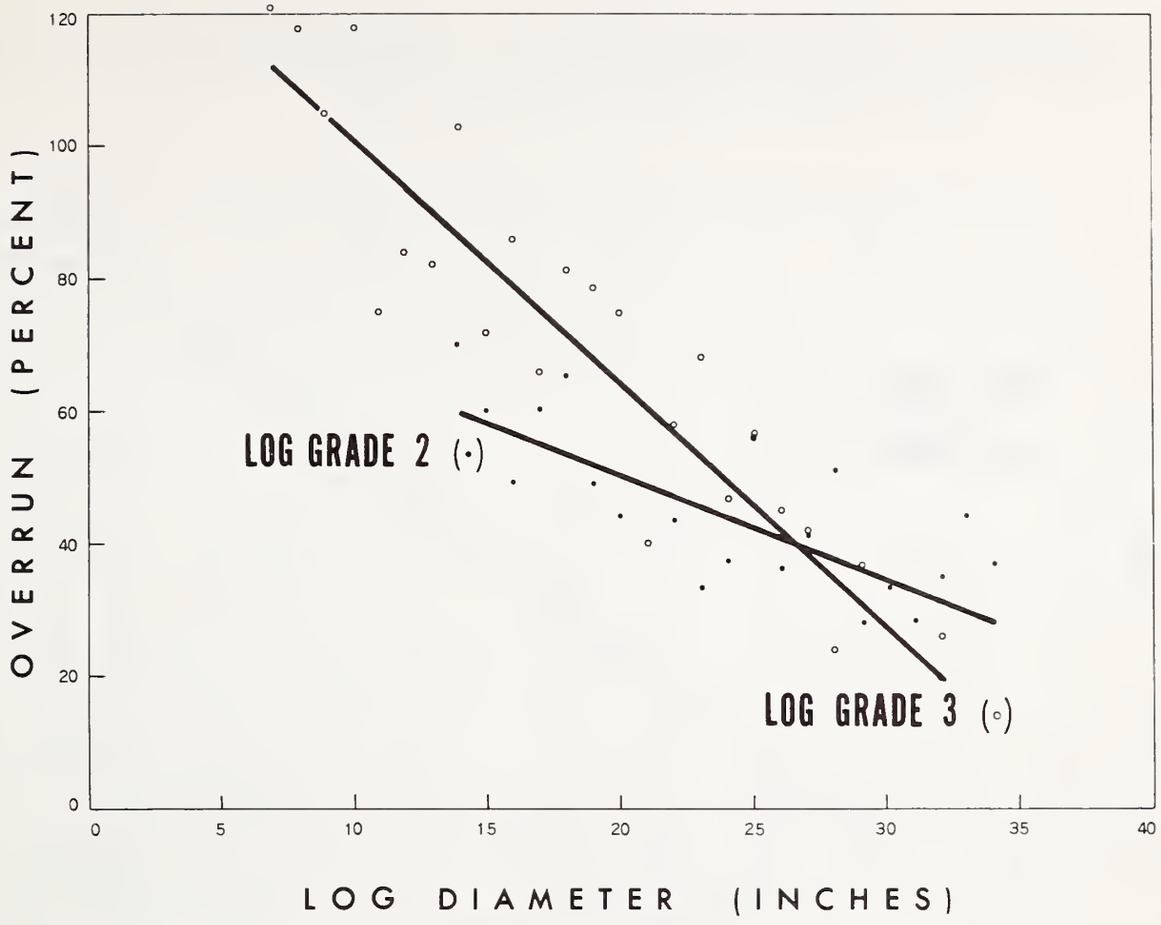

Figure 9.--Relationship of overrun to log diameter by log grade (Official Log Scaling and Grading Rules, applied to logs up to 40 feet in length).

Since a significant difference was found, the two log grade samples are considered to have been drawn from separate populations. The best way to use overrun data from this long-log study utilizing west-side practices is to separate overrun by log grade and log diameter. When the log value curves (fig. 8) based on lumber grade yield and overrun by log grade are used, this separation is effected.

Defect

At first thought, the different overruns observed might seem related to a difference in defect deductions made for the respective log grades. A close look at the plotting of defect deducted for individual diameters (fig. 10) shows the wide variability encountered and a thorough intermixing of points plotted for the two log grades. Regression lines showing the relationship of defect to log size were calculated for each log grade. When covariance analysis was applied, slopes and elevations of the regression lines were not found to be significantly different. As a result, a common regression line for the two log grades was

calculated, and the relationship of defect to log size is shown only by the line drawn in figure 10. The relationship is not affected by the log grades sampled in this study.

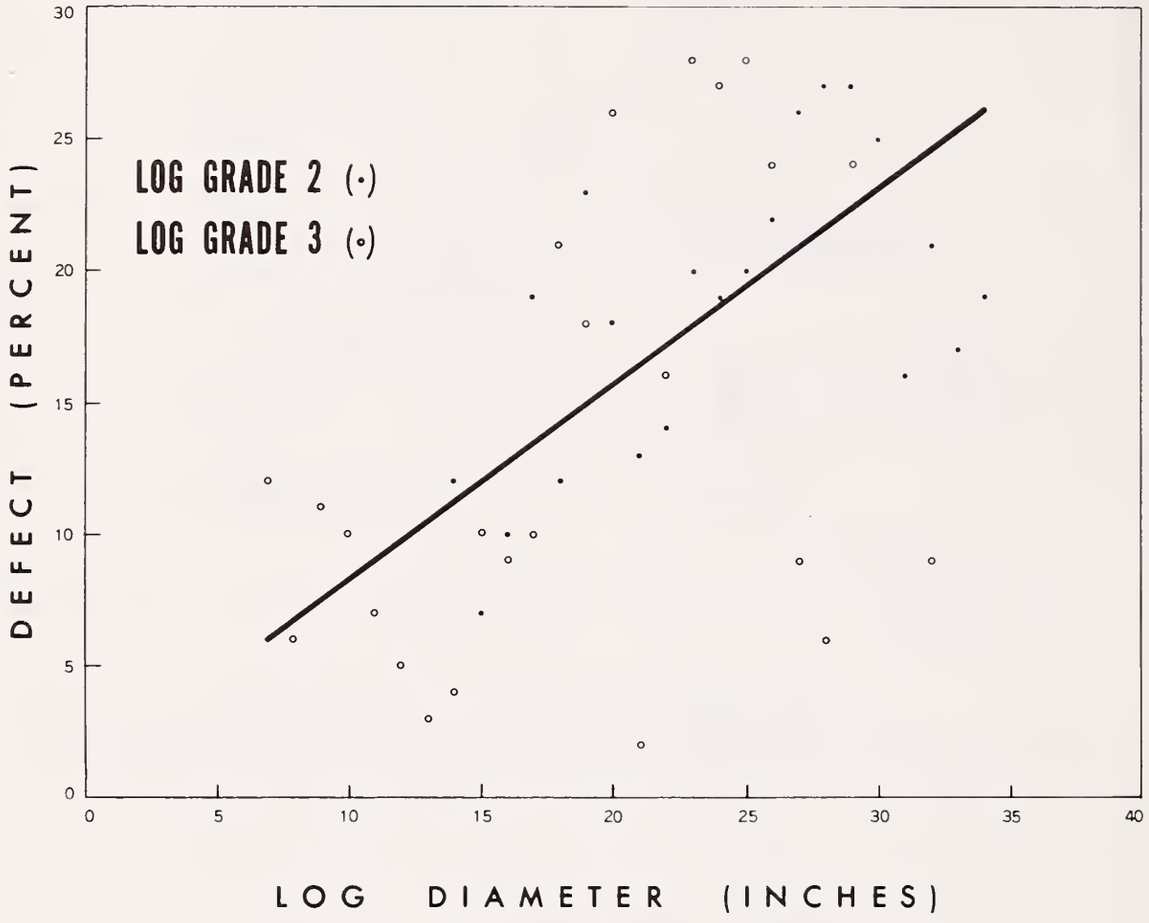

Figure 10.--Relationship of scaled defect to log diameter (Official Log Scaling and Grading Rules, applied to logs up to 40 feet in length).

West-Side Grading and Scaling Rules Applied to Short Logs

Distribution of 520 short logs (up to 22 feet in length) graded and scaled by west-side grading and scaling rules is presented in table 7. Net log scale, total lumber volume, and total lumber value for each log grade-diameter class sampled is included in table 8. This data is the basis for further calculations and analyses presented in table 9 for 6-inch diameter intervals which contained 10 or more logs of a single log grade.

Comparison of table 9 data with that presented in table 6 for long logs illustrates the effect of scaling practice on overrun. When a long log is bucked into shorter lengths for sawing and those short lengths are scaled, the log scale more nearly estimates lumber yield, and overrun is decreased. An example of this is a sound 34-foot log, 16 inches in diameter, with net scale of 340 board

Table 7.--Distribution of 520 white fir short logs, by diameter and log grade; southern Oregon, 1961[1/]

Diameter (inches)	No. 1	No. 2	No. 3	Total
	Number			
6- 8	--	--	24	24
9-11	--	--	55	55
12-14	--	16	49	65
15-17	--	58	22	80
18-20	--	49	21	70
21-23	1	50	13	64
24-26	1	40	17	58
27-29	--	47	10	57
30-32	--	23	4	27
33-35	1	16	--	17
36-38	--	3	--	3
Total	3	302	215	520

[1/] Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, Northern California, and Tillamook County Log Grading and Scaling Bureaus.

NOTE: The heavy lines enclose those log grade—log diameter intervals that are included in table 9. Data from all logs except grade No. 1 are summarized in tables 15 and 16 of the appendix.

Table 8.--Net log scale, total lumber volume, and total lumber value for white fir, by diameter and log grade; southern Oregon, 1961

Log diameter (inches)	Log grade[1/]								
	No. 1			No. 2			No. 3		
	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value	Net log scale	Lumber tally	Value
	----- Bd. ft. ----		Dollars	----- Bd. ft. -----		Dollars	----- Bd. ft. -----		Dollars
6	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	240	442	24.67
8	--	--	--	--	--	--	370	790	44.34
9	--	--	--	--	--	--	630	1,198	70.14
10	--	--	--	--	--	--	760	1,371	75.05
11	--	--	--	--	--	--	1,330	1,827	102.22
6-11	--	--	--	-- --	--	--	3,330	5,628	316.42
12	--	--	--	--	--	--	1,170	1,813	94.64
13	--	--	--	--	--	--	2,290	3,467	184.44
14	--	--	--	1,660	2,511	136.36	970	1,520	83.42
15	--	--	--	2,480	3,429	181.23	1,040	1,515	73.08
16	--	--	--	3,060	4,166	220.03	930	1,319	68.31
17	--	--	--	3,190	4,419	243.15	1,260	1,839	100.60
12-17	--	--	--	10,390	14,525	780.77	7,660	11,473	604.49
18	--	--	--	2,720	3,955	209.03	1,740	2,566	132.47
19	--	--	--	3,600	5,025	275.94	1,140	1,708	90.21
20	--	--	--	4,200	5,674	318.19	1,650	2,298	112.12
21	230	335	29.68	4,320	5,952	333.94	1,030	1,466	77.09
22	--	--	--	6,620	8,644	483.67	1,630	2,515	130.82
23	--	--	--	3,970	5,230	310.74	790	1,180	59.16
18-23	230	335	29.68	25,430	34,480	1,931.51	7,980	11,733	601.87
24	--	--	--	4,320	5,713	308.91	2,370	3,842	186.92
25	--	--	--	6,840	8,595	490.52	2,060	2,623	129.05
26	370	463	34.33	4,550	5,555	310.17	1,250	1,612	80.89
27	--	--	--	7,700	10,156	584.64	400	595	34.13
28	--	--	--	7,440	9,828	572.59	3,350	4,390	244.50
29	--	--	--	5,540	7,711	483.34	1,150	1,556	82.82
24-29	370	463	34.33	36,390	47,558	2,750.17	10,580	14,618	758.31
30	--	--	--	3,350	5,332	332.13	1,210	1,521	75.66
31	--	--	--	6,820	8,540	485.71	--	--	--
32	--	--	--	2,490	3,328	216.64	1,400	1,793	85.10
33	590	871	91.31	5,000	6,526	406.38	--	--	--
34	--	--	--	2,790	3,596	218.97	--	--	--
35	--	--	--	2,280	3,351	234.09	--	--	--
30-35	590	871	91.31	22,730	30,673	1,893.92	2,610	3,314	160.76
36	--	--	--	770	1,009	68.47	--	--	--
37	--	--	--	1,450	1,869	120.76	--	--	--

[1/] Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, Northern California, and Tillamook County Log Scaling and Grading Bureaus; applied to short logs, 22 feet or less in length.

Table 9.--Log input, lumber yield, and lumber value for white fir of southern Oregon, based on west-side log grading and scaling practices, 1961[1/]

LOG INPUT AND LUMBER YIELD

Item	Log grade and diameter interval							
	No. 2				No. 3			
	12-17	18-23	24-29	30-35	6-11	12-17	18-23	24-29
Logs.....number..	74	99	87	39	79	71	34	27
Gross log scale.....board feet..	11,420	30,400	47,770	30,150	3,500	8,280	9,750	13,940
Net log scale.....board feet..	10,390	25,430	36,390	22,730	3,330	7,660	7,980	10,580
Defect.....percent..	9	16	24	25	5	7	18	24
Lumber tally.....board feet..	14,525	34,480	47,558	30,673	5,628	11,473	11,733	14,618
Overrun.....percent..	40	36	31	35	69	50	47	38
GRADE YIELD (in percent of dry lumber tally)								
Select:								
C	1	2	2	4	2	1	1	1
D	0	1	2	3	0	0	0	1
Total	1	3	4	7	2	1	1	2
Shop:								
Molding	0	2	3	6	0	0	0	0
All Shop and Outs	0	1	5	6	0	2	2	3
Total	0	3	8	12	0	2	2	3
Common:								
Standard and Better	49	47	41	35	55	46	41	39
Utility	30	28	27	26	27	30	32	32
Economy	20	19	20	20	16	21	24	24
Total	99	94	88	81	98	97	97	95
LUMBER VALUE (in dollars)								
Basis:								
Per M b.m. lumber tally	53.75	56.02	57.83	61.75	56.22	52.69	51.30	51.88
Per M b.m. net log scale	75.15	75.95	75.57	83.32	95.02	78.92	75.42	71.67

[1/] Bureau log grades for hemlock, maximum scaling length 40 feet; applied to short logs, 22 feet or less in length.

feet. This log was bucked into a 16-inch, 16-foot log and an 18-inch, 18-foot log whose net scales were 160 and 240 board feet, respectively. A total of 540 board feet of lumber was recovered from these two segments. The short logs thus gave a combined overrun of 35 percent, compared with the 59 percent of overrun calculated from the long-log scale. No scale deductions were made from either the long log or the short logs bucked from it.

From tables 6 and 9, one can generalize that overruns obtained from long logs are higher than those from short logs in the same log grade-diameter class, except in the largest diameters sampled. This is what one would expect, since larger logs have less taper and overrun differences arising from log scaling practice should be smaller.

A broad idea of the effect overrun from short logs has on log value may be gained from table 9. A more complete picture may be obtained by comparing the curves in figure 11 with those in figure 8 for long-log values. Product recoveries on a net log scale basis were found to be consistently less for short logs until log diameters larger than 28 inches were compared.

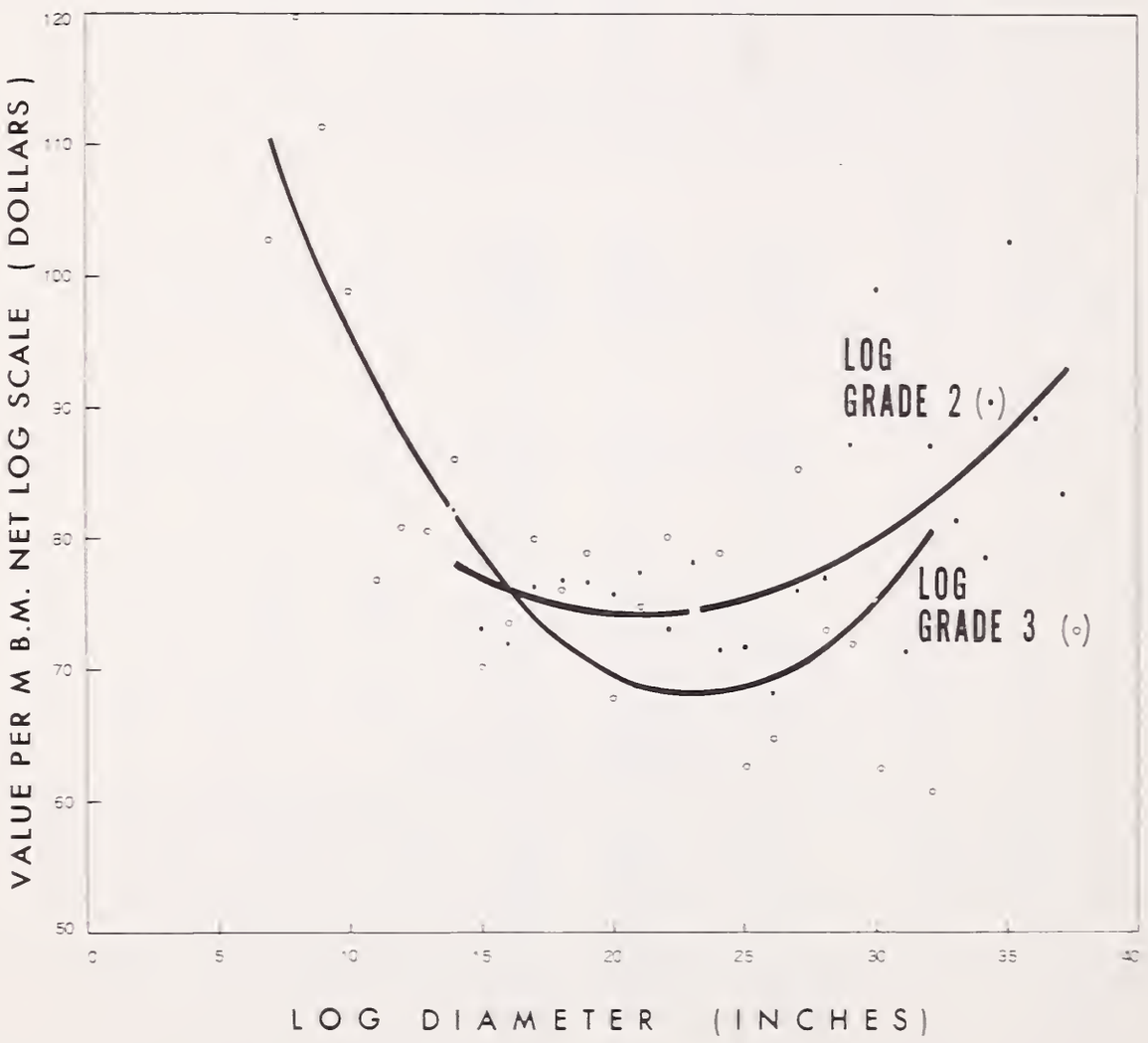

Figure 11.--Relationship of log value (dollars per thousand board feet, net log scale) to log diameter by log grade (Official Log Scaling and Grading Rules, applied to logs up to 22 feet in length).

APPENDIX

Trial Log Grades for Associated Species

Grade 1:

Size: Minimum diameter, 18 inches; minimum length, 12 feet.
Knots: 75 percent surface clear if 16 feet long. Shorter logs shall have 12 feet of 100 percent surface clear length.
Exception: Two pin knots allowed on the surface-clear portions.

Grade 2:

Size: Minimum diameter, 14 inches; minimum length, 12 feet.
Knots: Three types of logs

a. 20 inch plus logs--
One clear face and one face which has live and dead knots and indicators not over 1 inch in diameter. The other two faces may have any number of knots of any size.

b. 17- to 19-inch logs--
Two clear faces, with 1 pin knot allowable on one of the clear faces.

c. 14- to 16-inch logs--
Three clear faces. No pin knots allowed on the clear faces.

Grade 3:

Size: Minimum diameter, 12 inches; minimum length, 12 feet.
Knots: Any number of knots equal to one-sixth of the log diameter or less are permitted, except that one knot only, larger than one-sixth of the log diameter is permitted.

Grade 4:

Size: Minimum diameter 6 inches; minimum length, 8 feet.
Knots: Any number. Any merchantable log which will not grade out 1, 2, or 3, is automatically grade 4.

Explanatory notes:
A face is one-quarter of the log circumference for the full length of the log.
A clear face is one with no knots or knot indicators.
When a knot larger than one-sixth of the diameter occurs in a knot cluster, a decision must be made as to whether the scale or grade of the log will be affected. In such cases the following rules will apply--

a. Knot clusters or burls affecting the log to considerable width and depth require a scaling deduction and shall not be considered in grading associated species.

b. Knot clusters that are not large enough to require a scaling deduction shall be treated the same as though the large knot in the cluster was a single knot.

Table 10.--Surfaced dry lumber grade recovery from No. 2 white fir sawmill logs, by 1-inch diameter intervals, east-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C and Better	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
18	1	6.7	2.3	5.1	0	0	0.3	0	1.4	4.8	17.9	25.0	24.3	12.2	225
20	1	13.1	8.8	11.9	0.1	1.1	3.9	0.6	3.9	6.3	18.0	17.6	11.6	3.1	364
21	1	12.6	10.0	18.4	0	.2	1.2	.2	5.6	2.9	11.3	16.1	16.2	5.3	336
23	4	4.8	2.9	7.5	0	.1	.5	.1	2.2	6.0	18.8	23.7	22.0	11.4	1,452
26	2	4.9	2.6	2.6	.1	1.5	6.6	1.3	1.5	2.6	11.5	19.3	26.1	19.4	731
28	1	12.0	5.7	11.9	0	.1	.7	.1	3.4	1.7	7.7	13.7	22.7	20.3	463
30	1	11.8	6.2	23.3	.4	2.1	3.6	.5	6.4	1.8	7.4	11.7	14.8	10.0	692
33	1	5.2	3.7	10.0	0	.1	.7	.1	2.9	4.3	15.2	20.3	23.5	14.0	929
34	1	7.9	7.0	25.9	0	.9	3.6	.6	7.4	2.9	9.3	11.5	13.0	10.0	791
35	1	5.9	4.8	3.7	0	0	.2	0	1.5	8.6	19.5	22.1	21.1	12.6	1,009
36	1	.7	.1	.9	0	0	.1	0	.2	3.1	13.2	21.6	32.5	27.6	839

[1/] Trial Log Grades for Associated Species; maximum scaling length, 16 feet.

Table 11.--Surfaced dry lumber grade recovery from No. 3 white fir sawmill logs, by 1-inch diameter intervals, east-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C and Better	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
12	8	0.9	0	0	0	0	0	0	0	5.0	19.1	27.4	30.6	17.0	757
13	17	1.0	0.2	0.6	0	0	0	0	0.2	5.1	19.0	26.6	29.2	18.1	2,230
14	16	1.0	0	0	0	0	0	0	0	5.5	18.6	26.2	30.3	18.4	2,502
15	21	.9	.2	.6	0	0	0	0	.2	4.1	16.1	24.8	31.9	21.2	3,667
16	17	1.0	0	0	0	0	0	0	0	5.0	18.6	27.0	30.1	18.3	3,389
17	22	1.3	.3	.3	0	0.1	1.7	0.4	.6	4.9	17.1	24.8	28.9	19.6	5,062
18	26	1.3	.4	.6	0	.2	1.2	.3	.3	4.6	17.2	24.9	29.8	19.2	6,949
19	19	1.2	.2	.5	0	0	0	0	.2	5.7	18.2	24.5	28.8	20.7	5,588
20	25	1.2	.6	.9	0	.2	.7	.1	.3	4.6	16.8	24.4	29.4	20.8	7,830
21	12	1.8	1.2	1.2	0	0	.1	0	.4	5.7	19.1	26.2	28.0	16.3	4,104
22	23	1.4	.7	1.7	0	0	.1	0	.5	4.9	16.4	23.0	29.0	22.3	8,865
23	21	1.4	.9	1.7	0	.3	.8	.1	.5	3.9	15.6	23.9	30.3	20.6	9,074
24	16	1.4	.6	1.2	0	.3	1.8	.4	.7	4.0	15.2	22.4	29.5	22.5	6,888
25	20	1.2	.8	.8	0	.2	.6	.1	.4	4.5	16.6	24.3	29.7	20.8	9,564
26	17	1.5	1.0	2.1	0.1	.7	3.1	.7	1.1	3.7	14.3	21.8	28.5	21.4	9,074
27	15	1.2	.7	1.4	.1	.8	2.7	.5	.6	3.7	15.1	23.4	29.4	20.4	8,941
28	22	2.9	2.7	3.8	0	.5	2.1	.4	1.5	4.4	15.2	21.1	25.5	19.9	13,344
29	17	2.8	2.4	3.9	0	.6	2.5	.5	1.5	3.8	14.2	21.0	27.0	19.8	10,001
30	13	2.0	1.3	3.2	0	.4	1.4	.3	1.0	3.7	14.6	22.5	28.9	20.7	9,394
31	5	1.5	1.3	1.5	.1	1.7	5.8	1.0	.9	3.0	12.6	20.5	28.6	21.5	4,014
32	11	2.7	2.6	5.1	.1	1.2	3.3	.5	1.7	2.7	11.6	19.2	27.9	21.4	8,408
33	5	3.0	2.1	6.9	.2	1.2	2.9	.5	2.2	2.4	10.3	17.1	27.5	23.7	3,602
34	5	1.7	1.4	2.0	.2	1.2	1.4	.2	.7	4.0	15.7	23.4	28.6	19.5	4,521
35	1	6.6	10.5	7.8	0	.1	.5	.1	3.2	4.9	14.3	17.8	19.9	14.3	702
36	1	18.0	10.1	28.5	0	.4	1.9	.3	8.0	2.4	7.1	7.7	8.6	7.0	779
37	3	3.3	2.9	3.6	0	0	.2	0	1.2	3.9	14.3	20.4	27.9	22.3	2,929

[1/] Trial Log Grades for Associated Species; maximum scaling length, 16 feet.

Table 12.--Surfaced dry lumber grade recovery from No. 4 white fir sawmill logs, by 1-inch diameter intervals, east-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C and Better	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
6	1	1.4	0	0	0	0	0	0	0	12.4	31.4	25.4	16.4	13.0	35
7	8	2.4	0.4	0.4	0	0	0	0	0.1	6.8	19.7	26.0	27.8	16.4	357
8	13	.9	0	0	0	0	0	0	0	5.2	19.8	28.4	29.2	16.5	698
9	14	2.0	.6	.9	0	0	0.1	0	.3	7.0	22.2	28.2	25.7	13.0	925
10	19	1.6	.2	.2	0	0	0	0	0	6.2	19.7	24.7	27.7	19.7	1,589
11	16	1.4	.2	.6	0	0	0	0	.2	6.2	21.0	27.4	27.5	15.5	1,569
12	11	1.1	.1	.5	0	0	0	0	.1	5.2	16.5	24.6	31.2	20.7	1,186
13	4	.6	0	0	0	0	0	0	0	3.2	13.3	21.4	32.2	29.3	622
14	5	.9	.1	.5	0	0	0	0	.1	4.6	18.0	26.5	30.8	18.5	1,018
15	9	1.4	.3	.6	0	0	0	0	.2	3.9	14.3	22.3	31.7	25.3	1,526
16	3	.7	0	0	0	0	0	0	0	3.7	15.9	25.4	32.5	21.8	704
17	3	.8	0	0	0	0	0	0	0	4.8	17.0	23.6	29.6	24.2	666
18	2	.4	0	0	0.1	2.4	16.5	3.8	3.0	2.0	8.8	15.3	25.2	22.5	416
19	2	.6	0	0	0	0	0	0	0	2.5	12.4	22.4	34.8	27.3	566
20	2	.4	0	0	0	0	0	0	0	1.3	8.4	17.9	36.8	35.2	611
21	2	.4	0	0	0	0	0	0	0	1.8	8.6	16.4	35.1	37.7	514
22	3	.5	0	0	0	0	0	0	0	2.0	10.4	19.7	35.2	32.2	1,223
24	1	.6	0	0	0	.6	4.1	.9	.7	2.6	12.4	21.6	31.5	25.0	447
25	2	.6	0	0	0	0	0	0	0	2.7	12.8	22.6	33.9	27.4	887
28	1	.7	0	0	0	.3	.9	.1	0	3.4	16.2	27.4	33.4	17.6	715
31	1	.8	0	0	0	.3	.9	.1	0	3.8	16.7	27.2	33.2	17.0	723

[1/] Trial Log Grades for Associated Species; maximum scaling length, 16 feet.

Table 13.--Surfaced dry lumber grade recovery from No. 2 white fir sawmill logs, by 1-inch diameter intervals, west-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
14	9	0.9	0.1	0.6	0	0	0	0	0.2	4.8	17.4	25.5	31.1	19.4	3,022
15	8	1.0	0	0	0	0	0	0	0	5.0	17.2	25.5	31.3	20.0	3,179
16	10	1.9	.4	.8	0	0	0	0	.2	5.0	17.7	24.5	28.6	20.9	4,215
17	9	1.2	.4	.1	0	0	0	0	.1	5.2	17.4	24.8	29.7	21.1	3,860
18	6	1.3	.6	.6	0	0.2	0.9	0.2	.4	6.2	20.4	26.1	27.3	15.8	3,333
19	7	1.8	1.2	1.5	0	0	.1	0	.5	5.3	16.9	23.4	28.7	20.6	3,461
20	12	2.1	1.2	2.3	0	.1	.4	.1	.7	4.5	16.5	23.8	28.9	19.4	8,403
21	6	2.1	1.2	3.6	0	.1	.6	.1	1.0	5.3	17.3	23.7	26.9	18.1	4,890
22	13	2.1	1.3	1.8	0	0	.2	0	.6	4.3	16.4	23.9	29.2	20.2	11,290
23	3	1.2	.6	1.0	0.1	1.1	5.3	1.2	1.2	5.0	17.4	23.4	25.5	17.0	2,568
24	4	3.1	2.0	2.3	0	0	.1	0	.8	4.6	15.6	22.5	27.9	21.1	3,795
25	5	1.8	1.1	2.2	0	.7	3.1	.6	.9	4.2	15.6	22.7	27.2	19.9	6,150
26	6	2.2	1.5	3.7	0	.3	1.4	.2	1.2	4.5	15.7	22.4	27.0	19.9	6,772
27	13	2.5	2.2	3.2	0	.5	3.1	.7	1.6	4.4	15.8	22.2	26.1	17.7	15,880
28	4	4.4	3.2	8.1	.1	.7	2.6	.5	2.6	2.7	11.3	18.1	25.7	20.0	5,436
29	4	3.8	3.7	7.3	.1	.7	2.1	.3	2.3	4.1	14.6	20.2	23.5	17.3	4,309
30	5	2.0	1.3	1.1	0	.2	.8	.1	.5	3.5	14.2	22.1	30.6	23.6	7,009
31	5	4.8	3.7	9.5	.2	2.1	6.6	1.1	3.1	2.3	9.9	16.0	23.0	17.7	8,077
32	1	7.4	7.9	20.3	.2	1.5	3.2	.5	6.0	2.6	9.2	12.6	16.0	12.6	1,666
33	2	1.9	2.1	.8	0	0	0	0	.5	3.3	13.6	21.6	31.6	24.6	3,971
34	4	6.6	5.1	8.8	.2	.8	1.4	.2	2.7	4.3	13.7	18.5	22.0	15.7	6,992

[1/] Official Bureau log grades for hemlock; maximum scaling length, 40 feet.

Table 14.--Surfaced dry lumber grade recovery from No. 3 white fir sawmill logs, by 1-inch diameter intervals, west-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
7	9	2.3	0.4	0.3	0	0	0	0	0.1	6.3	19.2	26.0	27.7	17.7	774
8	17	1.7	.4	.4	0	0	0	0	.1	5.6	19.9	26.8	28.1	17.0	1,790
9	13	1.4	.1	.2	0	0	0	0	.1	7.6	22.6	27.3	26.0	14.7	2,096
10	7	.7	.1	.6	0	0	0.1	0	.2	2.8	13.5	23.3	33.7	25.0	1,352
11	12	1.3	.1	0	0	0	0	0	0	6.8	20.5	27.2	28.2	15.9	1,992
12	12	.9	.1	.5	0	0	0	0	.1	4.3	17.0	25.6	30.9	20.6	2,560
13	16	1.0	.1	.3	0	0	0	0	.1	5.1	18.7	26.6	29.6	18.5	5,325
14	8	1.4	.4	.5	0	0.3	2.2	0.5	.6	4.5	16.4	23.7	29.2	20.3	3,085
15	7	.8	.1	.7	0	0	.1	0	.2	3.8	14.9	22.8	30.9	25.7	2,114
16	4	1.0	.5	.3	0	0	0	0	.1	4.1	15.6	24.3	31.4	22.7	2,117
17	6	1.2	.6	2.2	0	.4	3.9	1.0	1.5	4.4	16.0	22.3	26.7	19.8	3,153
18	4	.6	.1	0	0	0	0	0	0	2.8	13.1	22.8	34.4	26.2	2,276
19	2	1.3	.3	.2	0	.7	2.7	.5	.3	4.1	15.8	23.6	29.0	21.5	1,501
20	5	.8	.2	1.0	0.1	.9	2.4	.4	.3	3.9	15.2	22.8	29.6	22.4	3,546
21	3	.9	.3	.2	0	0	0	0	.1	4.1	16.3	24.9	30.9	22.3	2,191
22	4	.7	.3	.1	0	0	0	0	.1	2.9	13.2	22.5	33.6	26.6	2,856
23	4	1.1	.4	1.2	0	.3	1.2	.3	.6	2.9	12.4	20.9	31.6	27.1	3,175
24	5	.7	.2	.4	0	0	0	0	.1	2.9	12.5	20.9	33.5	28.8	4,628
25	2	3.3	3.4	2.2	.3	2.6	7.1	1.3	1.4	3.3	12.1	19.3	25.9	17.8	2,229
26	2	.9	.6	.5	0	.3	.9	.1	.2	3.1	14.2	23.7	32.8	22.7	2,354
27	1	1.0	.1	.7	0	0	.1	0	.2	5.2	19.6	27.7	29.0	16.4	1,503
28	1	.7	0	0	0	.3	.9	.1	0	3.6	16.4	27.3	33.4	17.3	1,438
29	3	.7	.1	.3	.1	.6	1.9	.3	.2	2.6	12.7	22.4	33.6	24.5	4,426
32	1	.6	.1	.4	0	0	0	0	.1	2.4	11.4	20.3	34.5	30.2	1,791

[1/] Official Bureau log grades for hemlock; maximum scaling length, 40 feet.

Table 15.--Surfaced dry lumber grade recovery from No. 2 white fir sawmill logs, by 1-inch diameter intervals, west-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
14	16	1.0	0.2	0.6	0	0	0	0	0.2	4.9	18.3	26.6	30.5	17.7	2,511
15	18	.8	0	.2	0	0	0	0	.1	4.2	17.3	26.4	32.0	19.0	3,429
16	20	1.3	.2	.4	0	0	0	0	.1	4.7	16.8	24.5	30.4	21.6	4,166
17	20	1.9	.7	.6	0	0	0	0	.2	5.0	17.9	25.3	28.7	19.7	4,419
18	14	1.0	.1	.3	0	0	0	0	.1	4.9	17.4	25.1	30.8	20.3	3,955
19	17	1.3	.3	.6	0	0	0	0	.2	6.2	19.4	25.2	28.1	18.7	5,025
20	18	1.9	1.3	1.7	0	0.2	0.9	0.2	.7	4.5	16.6	23.7	28.5	19.8	5,674
21	16	1.7	1.0	2.3	0	0	.2	0	.7	5.2	17.1	24.1	28.3	19.4	5,952
22	21	1.7	.9	2.1	0	0	.2	0	.6	5.2	17.6	24.0	28.0	19.7	8,644
23	13	2.7	1.8	3.0	0.1	.5	1.3	.2	1.0	4.6	16.8	23.6	27.2	17.2	5,230
24	13	1.2	.7	1.2	0	.2	1.5	.4	.7	4.3	16.1	23.5	29.0	21.2	5,713
25	17	1.7	1.0	1.8	.1	.9	3.4	.7	.9	4.4	16.1	23.4	27.2	18.4	8,595
26	10	1.7	1.2	2.2	0	.2	1.7	.4	1.1	4.4	15.6	22.6	28.4	20.5	5,555
27	18	2.1	1.6	3.3	0	.3	1.9	.4	1.4	4.1	15.4	22.5	27.5	19.5	10,156
28	16	2.3	2.1	2.8	0	.6	2.1	.4	1.1	4.5	15.8	22.0	26.2	20.1	9,828
29	13	3.7	3.1	5.8	0	.8	3.2	.6	2.1	3.6	13.6	20.0	25.2	18.3	7,711
30	7	3.5	2.5	6.8	.1	.5	1.4	.3	2.1	3.4	13.8	21.3	26.7	17.6	5,332
31	11	1.8	1.4	2.9	.1	1.6	5.5	1.0	1.1	2.9	12.2	19.8	27.9	21.8	8,540
32	5	4.9	4.9	7.0	.1	.7	1.2	.2	2.3	3.2	12.6	18.9	25.3	18.7	3,328
33	8	3.4	2.8	8.8	.1	.8	2.1	.4	2.6	2.7	11.2	18.0	26.5	20.6	6,526
34	4	2.6	3.1	3.7	.3	1.5	1.8	.2	1.3	4.2	15.2	21.8	26.1	18.2	3,596
35	4	8.5	5.3	11.1	0	.1	.7	.1	3.3	2.3	9.3	15.0	23.5	20.8	3,351
36	1	5.9	4.8	3.7	0	0	.2	0	1.5	8.6	19.5	22.1	21.1	12.6	1,009
37	2	4.5	4.4	5.5	0	.1	.4	.1	1.9	5.0	16.5	20.8	23.8	17.0	1,869

[1/] Official Bureau log grades for hemlock; maximum scaling length, 22 feet.

Table 16.--Surfaced dry lumber grade recovery from No. 3 white fir sawmill logs, by 1-inch diameter intervals, west-side practice, southern Oregon, 1961[1/]

Log diameter (inches)	Number of logs	Lumber grade													Total lumber tally
		C	D	Molding	Factory Select	No. 1 Shop	No. 2 Shop	No. 3 Shop	Shop Outs	Select Merchantable	Construction	Standard	Utility	Economy	
		Percent of total recovery													Bd. ft.
7	10	2.1	0.3	0.3	0	0	0	0	0.1	6.7	19.6	25.1	27.8	18.0	442
8	14	1.6	.3	.6	0	0	0	0	.2	5.1	19.5	27.9	29.2	15.6	790
9	17	1.4	.3	.3	0	0	0	0	.1	8.0	24.4	28.9	23.9	12.7	1,198
10	17	1.7	.2	.2	0	0	0	0	.1	5.6	19.0	25.8	28.6	18.8	1,371
11	21	1.3	.2	.5	0	0	0	0	.1	5.9	20.7	27.4	28.0	15.9	1,827
12	17	1.1	.1	.5	0	0	0	0	.1	5.0	16.1	23.9	31.4	21.8	1,813
13	23	1.0	.1	.3	0	0	0	0	.1	5.1	17.7	25.4	30.1	20.2	3,467
14	9	1.7	.3	.9	0	0	0.1	0	.3	5.4	18.1	25.0	28.8	19.4	1,520
15	9	.6	0	0	0	0	0	0	0	3.0	12.9	21.7	33.6	28.2	1,515
16	6	1.0	.4	.1	0	0	0	0	.1	4.3	15.6	24.4	31.7	22.4	1,319
17	7	.8	0	.1	0	0.6	6.2	1.6	1.5	4.2	16.0	23.4	27.3	18.3	1,839
18	9	.7	.1	0	0	.4	2.7	.6	.5	3.9	15.1	22.4	30.3	23.3	2,566
19	5	.7	.1	.8	0.1	1.1	3.9	.7	.4	3.2	13.8	22.3	30.2	22.7	1,708
20	7	.7	.2	.7	0	0	.1	0	.2	2.9	12.6	21.3	32.8	28.5	2,298
21	4	.9	.3	.1	0	0	0	0	.1	4.2	16.9	26.0	30.4	21.1	1,466
22	6	1.1	.4	.2	0	.3	.8	.1	.1	3.4	14.8	24.0	32.6	22.2	2,515
23	3	.6	0	0	0	.2	1.5	.3	.3	3.1	13.7	22.9	32.7	24.7	1,180
24	8	.7	.3	.3	0	.1	.5	.1	.2	2.8	12.2	20.6	33.4	28.8	3,842
25	6	.7	.1	.5	0	.1	.3	0	.2	2.8	12.9	22.1	33.2	27.1	2,623
26	3	.8	.5	.6	0	.4	1.2	.2	.2	2.6	12.3	21.6	33.7	25.9	1,612
27	1	.6	.1	.3	.7	6.4	16.7	2.8	.7	1.5	7.7	14.5	25.6	22.4	595
28	7	2.1	1.7	.7	.1	.5	1.1	.2	.4	4.0	15.4	23.7	30.1	20.0	4,390
29	2	.8	.1	.7	0	0	1.0	.3	.4	4.0	16.5	25.5	31.6	19.1	1,556
30	2	.6	0	0	0	.5	1.5	.2	0	2.8	13.0	22.4	33.6	25.4	1,521
32	2	.5	0	0	0	0	0	0	0	2.5	11.9	21.1	34.9	29.1	1,793

[1/] Official Bureau log grades for hemlock; maximum scaling length, 22 feet.

Table 17.--Surfaced dry lumber prices used in calculating values for white fir

Lumber grades		Thickness weighting factor (in percent)	Price per M b.m.	
Developed in study	From WPA summary		From WPA summary[1]	Used in study
4/4 and Thicker C and Better	4/4 C and Better Select	11.34	$157.87	--
	5/4 and Thicker C and Better	88.66	158.63	[2] $158.54
4/4 and Thicker D	4/4 D Select	14.57	122.85	--
	5/4 and Thicker D Select	85.43	133.12	[2] 131.62
4/4 and Thicker Molding	4/4 and Thicker Molding Stock	--	122.40	122.40
5/4 Factory Select	5/4 and Thicker Factory Select	--	121.42	121.42
5/4 No. 1 Shop	5/4 and Thicker No. 1 Shop	--	109.77	109.77
5/4 No. 2 Shop	5/4 and Thicker No. 2 Shop	--	78.88	78.88
5/4 No. 3 Shop	5/4 and Thicker No. 3 Shop	--	59.00	59.00
5/4 Shop Outs	4/4 and Thicker Box Lumber	--	46.45	46.45
4/4 Select Merchantable and Construction	4/4 No. 2 and Better Common	7.40	87.58	--
8/4 Select Merchantable and Construction	1-5/8 inch Construction	92.60	70.90	[2] 72.14
4/4 Standard	4/4 No. 3 Common	4.38	60.80	--
8/4 Standard	1-5/8 inch Standard	95.62	63.37	[2] 63.26
4/4 Utility	4/4 No. 4 Common	3.77	49.03	--
8/4 Utility	1-5/8 inch Utility	96.23	44.22	[2] 44.40
4/4 Economy	4/4 and Thicker No. 5 Common	2.75	33.28	--
8/4 Economy	1-5/8 inch Economy	97.25	25.12	[2] 25.34

[1] 1960 average prices for white fir taken from Western Pine Association's annual price summary dated January 9, 1960.

[2] Weighted by lumber thicknesses developed in study.

Estep, Eldon M., and Hunt, Douglas L.
1964. Lumber yield and log values of white fir. U.S. Forest Serv. Res. Paper PNW-20, 35 pp., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.

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